

U.S. Patent Application Serial No. **10/566,719**
Amendment filed March 11, 2008
Reply to OA dated December 13, 2007

REMARKS

Claims 1-16 are pending in this application. Claim 12 is amended, and claim 17 is newly added herein. Upon entry of this amendment, claims 1-17 will be pending. A minor amendment is also made to the specification. Entry of this amendment and reconsideration of the rejections are respectfully requested.

No new matter has been introduced by this Amendment. Support for the amendments to the claims is discussed below. The amendment to the specification provides a minor correction for consistency with the preceding sentence.

Claims 12-14 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. (Office action p. 2)

The Examiner refers to the recitation of “the nongel-like thermosetting resin” in claim 12 as not having antecedent basis. The Examiner has interpreted this as referring to “nongel-like epoxy resin composition” of the base claims.

The rejection is overcome by the amendment to claim 12. In claim 12, “the nongel-like thermosetting resin composition” has been amended to --the nongel-like epoxy resin composition--.

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Claims 1-16 are rejected under 35 U.S.C. §103(a) as being unpatentable over Haraguchi et al. (WO 03/037985) in view of Hanson et al. (U.S. 2002/0168527). Citations made to PCT refer to the English language equivalent (U.S. 2004/0254328). (Office action p. 3)

With regard to claim 1, the Examiner cites Haraguchi WO '985 as disclosing an epoxy resin composition comprising an epoxy resin having two or more epoxy groups in the molecule (paragraphs [0002] and [0024]), an amine (paragraph [0018]) and a borate compound of formula $B(OR)_n(OH)_{3-n}$.

The Examiner states that Haraguchi does not disclose a “polyamine borate” made from a polyamine compound as recited in claim 1. Hanson is cited for disclosing an epoxy resin composition with “a curing agent of the reaction of amines, specifically melamines with Lewis acids, specifically oxides and hydroxides of boron as well as amine-boron complexes,” citing paragraph [0069]. Melamine is cited as having amino and imino groups. The Examiner combines the references by combining “the reaction product of Hanson et al. with the composition of Haraguchi et al.” with the motivation “for such desirable properties as flame retardancy in addition to curing.”

The rejection of claims 1-16 is respectfully traversed, and reconsideration is requested. In traversing the rejection, Applicant submits that the references cannot be combined to produce the present invention, and, moreover, that unexpected results are associated with the claims. Applicant notes the following points regarding the disclosures of the cited references.

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Regarding Hararguchi et al.

In Hararguchi et al., an amine-modified epoxy resin is prepared first, and then, the resin is mixed with borates. In the present invention, a polyamine borate is generated from a reaction between a polyamine-based compound (A) having at least one of an amino group and imino group in the molecule and a boric acid-based compound (B) first, and then the generated polyamine borate is mixed with an epoxy resin.

The order of preparation steps is important. For example, when polyamine, boric acid, an epoxy resin and the like are mixed at once, selections regarding the solvent, the molar ratio between polyamine and boric acid, reaction conditions, and the like, are limited due to the use of the epoxy resin, and optimum conditions for reacting the boric acid and polyamine are not selected. As a result, unreacted polyamine and boric acid are also generally included in the obtained mixture in addition to the target polyamine borate.

When the content of the unreacted polyamine increases, the effect of increasing the glass transition point is not sufficiently achieved. When the content of the unreacted boric acid increases, the unreacted boric acid is not compatible with the epoxy resin and precipitates unpreferably, and an unsuitable non-uniform milky cured product is generated.

Accordingly, sufficient effects cannot be obtained when the method disclosed in Hararguchi et al is used.

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Regarding Hanson et al.

Hanson is cited for the disclosure of “amine-boron complexes” at paragraph [0069]. However, Hanson refers to amine-boron complexes as “**other** curing agents” (paragraph [0069], line 21), that is, as **different** from the previously listed amine hardeners and combinations of nitrogen-containing catalysts with Lewis acids. The term “amine-boron complexes” is **not explained** in Hanson, and there is no specific disclosure that this be based on a **polyamine**. Therefore, there is **no clear disclosure or suggestion** in Hanson for a **polyamine** borate hardener. Accordingly, the combination of Hanson et al. with Haraguchi et al. does **not** provide the “polyamine borate” required in the present claims.

Moreover, the Office Action states that Hanson et al. discloses an epoxy resin with a curing agent of the reaction of amines, specifically melamines with Lewis acids, specifically oxides and hydroxides of boron as well as amine-boron complexes (paragraph [0069]). However, paragraph [0069] of Hanson et al., which discloses examples of curing agents, discloses ethylenediamine and dicyandiamide as well as amine-boron complexes and compounds obtained by the reaction of amines such as melamines with Lewis acids such as oxides and hydroxides of boron.

In the present specification, ethylenediamine and dicyandiamide were used as comparative compounds in Comparative Examples 1, 2 and 4 of the present specification, and the heat resistance thereof was not improved.

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Therefore, in addition to there being no clear disclosure or suggestion of an amine borate in Hanson et al., the superior results associated with the use of polyamine borate, as opposed, for example, to the ethylenediamine, dicyandiamide and the like, used in Hanson et al., are clearly unexpected based on the reference.

Further comments regarding the present invention

In the present invention, a polyamine borate is generated from a reaction between a polyamine-based compound (A) having at least one of an amino group and an imino group in the molecule and a boric acid-based compound (B) first, and then the generated polyamine borate is mixed with an epoxy resin.

In general, when polyamine is reacted with boric acid, amine-condensed borate is generated, and water is also generated necessarily in the reaction process since water is generated by the condensation. In the present invention, a polyamine borate can react with an epoxy resin without the presence of such water, since a washing step, precipitation step or the like can be conducted in order to remove water, and adverse effects are not caused.

Furthermore, due to the use of a polyamine borate, an excellent high glass transition temperature of an epoxy resin can be achieved. This is an unexpected effect of the present invention. Furthermore, in the present invention, when the polyamine borate is generated, it is possible to remove unreacted boric acid and unreacted polyamine by a washing step or the like, even if unreacted boric acid and unreacted polyamine remain after a reaction of generating the polyamine borate. When such a polyamine borate from which unreacted boric acid, unreacted polyamine and

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the like are removed, is used, a cured product which can have an excellent high glass transition temperature can be generated.

In the present invention, since a polyamine borate which is generated from a reaction between a polyamine-based compound (A) and a boric acid-based compound (B) is used, a borate group can be introduced into an epoxy resin at the molecular level. Accordingly, due to the use of the polyamine borate for curing an epoxy resin, the borate content within the epoxy resin can increase, and therefore, the glass-transition temperature, elastic modulus and strength of a cured product generated from the epoxy resin composition can increase or be improved. Furthermore, it is possible to decrease the coefficient of thermal expansion of a cured product generated from the epoxy resin composition, and the cured product can have flame retardancy. Furthermore, in addition to a high glass transition temperature and absence of remaining water, the present invention has superior properties including excellent storage stability and distribution/transportation properties of the resin composition.

Such excellent effects of the present invention are unexpected from the disclosures of Hararguchi et al. and Hanson et al. Pending claims 1-16 are therefore not obvious over Haraguchi et al. and Hanson et al., taken separately or in combination.

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Regarding new claim 17.

Support for new claim 17 may be found, for example, on page 14, lines 8-24, of the specification. Claim 17 is dependent from claim 1, and Applicant's above arguments regarding the patentability of claim 1 are applicable to claim 17.

If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact the applicants' undersigned agent at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, the applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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